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CATALOGUE OF THE FLORA OF KANSAS, PART I.

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(Read by title before the Academy, at Ottawa, Kan., December 31, 1909.)

INTRODUCTION.

THIS catalogue is preliminary to the fulfillment of a complete catalogue of the flora of Kansas, in which it is designed to include every species of plant that grows spontaneously in the state, whether indigenous or naturalized, with some small account of its station, habitat and time of blooming, as well as its place in a systematic list. The lowest subkingdom, embracing all the orders of plant life up to the liverworts, and containing approximately 1400 species, is not yet ready for publication, but is reserved for further microscopic study, to be issued later. The catalogue of the higher subkingdoms will be divided into three or more parts, of which one part is here presented.

An attempt, partially successful, is made in this work to bring botanical classification into harmony with itself and give the various groups of a rank uniform endings. With that end in view, as far as possible, names of the great primary divisions (subkingdoms) end with *ata*, based upon some characteristic that pervades the group; primary subdivisions (*phyla*) end with *phyta*, as usual; the next great subdivisions (*subphyla*) end in *ones*; classes end with the customary *ineæ* or *ifereæ*; subclasses with *floræ*; orders end with *ales*, and family names with *aceæ*, all based upon some typical generic name or some characteristic of the group.

Much study has been made of late years to learn all that may be learned of the microscopic vegetation of the state, which is no unimportant consideration and involves no small amount of persistent and well-directed labor. With three or more powerful and well-equipped compound microscopes under our hands and a perfect familiarity with them brought about by years of experience (many when all are added together as students and teachers), it is to be hoped that our labors will produce many useful facts and that our lists when presented will be well worthy of consideration.

It is due to John H. Schaffner, A. M., M. S., professor of botany at the Ohio State University, to say that in the early stages of preparation of this catalogue he has had much to do. His advice in arrangement, classification and nomenclature has been

constantly sought and freely given, yet seldom has been religiously followed. Nevertheless, his counsel has necessarily been of great service.

In the following pages herbaria in which specimens of the plants of the state are contained are indicated by initials as far as known. (A) represents the herbarium of the State Agricultural College, which is very full as to representatives of the Kansas flora, as prepared by Doctor Kellerman, now deceased, and Prof. A. S. Hitchcock; (S) is the State herbarium, in charge of the principal author; also stands for the private herbaria of the authors as well as the herbarium of Professor Schaffner, which is richly supplied with Kansas plants and is a part of the foundation of this catalogue; (U) is the herbarium of the Kansas State University, of which the authors have a list.

A few names are included on the authority of Mr. Coville or some of the botanists of the Department of Agriculture at Washington. It is not the aim to include any plants not known to exist in the state.

That there should be errors in the present catalogue is unavoidable and rather to be expected. All such discovered in season will be eliminated in the permanent flora, publication of which will necessarily be some years off yet. Correspondents will be thanked for calling attention to any veiled errors; obvious ones are evident enough and will need no pointing out.

Until some student of mosses comes into the state and works up the material available, the public must be content with the desultory work of various students, who have always done the best they knew in making determinations, such as have been published in the various numbers of the Bulletin of the Washburn Laboratory of Natural History by Prof. F. W. Cragin; Smyth's "Check-list of the Plants of Kansas"; the papers of MM. Renauld and Cardot in *Botanical Gazette*, almost entirely from material collected in Saline county by Dr. Joseph Henry; and the collections of Miss Minnie Reed in Wyandotte, Pottawatomie, Riley and other counties, and published in vol. XIV of the Transactions of the Kansas Academy of Science. Since then almost the only work done in the state in collection and determination of mosses has been by Miss Grace Meeker, of Ottawa, which of itself has not been small. It is hoped now that some students will wake up to the importance of studying the mosses of the state.

All persons interested in the flora of Kansas are invited to correspond with the authors. Let us know what you have learned of

the flora of any part of Kansas, whether we have listed it or not. Wake up and do something.

Herewith is presented a scheme of classification and arrangement that is adapted to the accompanying catalogue of the flora of Kansas:

SCHEME OF CLASSIFICATION AND ARRANGEMENT.

(As adapted to the Flora of Kansas.)

Subkingdom II. ARCHEGONIATA. Archegoniate Spore-bearing Plants.

Phylum I. BRYOPHYTA (Muscineæ). Mosses and Liverworts.

Class I. MARCHANTINEÆ (Hepaticæ). Liverworts.

ORDER I. MARCHANTIALES. THE THALLOID LIVERWORTS.

Family 1. RICCIACEÆ. Crystalwort family.

Riccia.

Family 2. MARCHANTIACEÆ. Liverwort family.

Marchantia.

Preissia.

Fimbriaria.

Conocephalus.

Asterella.

Family 3. ANTHOCEROTACEÆ. Hornwort family.

Anthoceros.

Notothylas.

ORDER II. JUNGERMANNIALES. THE SCALE MOSSES.

Family 4. JUNGERMANNIACEÆ. Scale-moss family.

Frullania.

Lejeunea.

Ptilidium.

Lophocolea.

Chiloscyphus.

Jungermannia.

Fossombronina.

Pallavicinia.

Pellia.

Aneura.

Class II. BRYINEÆ (Musci). Mosses.

ORDER III. PHASCALES. THE CLEISTOCARPOUS MOSSES.

Family 5. MICROMITRIACEÆ. Micromitrium family.

Ephemerum.

Family 6. PHASCACEÆ. Phascom family.

Phascom.

Pleuridium.

Microbryum.

Family 7. ARCHIDIACEÆ. Archidium family.

Archidium.

ORDER IV. BRYALES. THE TRUE MOSSES.

Suborder A. ACROCARPI. Capsules Terminal.

Family 8. DICRANACEÆ. Dicranum family.

Astomum.

Gymnostomum.

Weisia.

Dicranella.

Dicranum.

Campylopus.

Fissidens.

Leucobryum.

Ceratodon.

Family 9. POTTIACEÆ. Pottia family.

Pottia.

Didymodon.

Leptotrichum.

Barbula.

ORDER IV. **BRYALES.** THE TRUE MOSSES.*Suborder A. ACROCARPI. Capsules Terminal.*Family 10. GRIMMIACEÆ. *Grimmia* family.

Grimmia.
Ceschinodon.
Ptychomitrium.
Orthotrichum.

Family 11. FUNARIACEÆ. *Funaria* family.

Pyramidula.
Physcomitrium.
Funaria.

Family 12. BRYACEÆ. *Bryum* family.

Bartramia.
Leptobryum.
Webera.
Bryum.
Mnium.
Timmia.

Family 13. POLYTRICHACEÆ. *Polytrichum* family.

Atrichum.
Polytrichum.

Family 14. FONTINALACEÆ. *Fontinalis* family.

Fontinalis.

*Suborder B. PLEUROCARPI. Capsules Axillary.*Family 15. NECKERACEÆ. *Neckera* family.

Meteorium.

Family 16. FABRONIACEÆ. *Fabronia* family.

Fabronia.

Family 17. LESKEACEÆ. *Leskea* family.

Thelia.
Leskea.
Anomodon.
Pylaisia.
Entodon.
Climacium.

Family 18. HYPNACEÆ. *Hypnum* family.

Thuidium.
Brachythecium.
Eurhynchium.
Rhynchostegium.
Plagiothecium.
Amblystegium.
Campyllum.
Harpidium.
Hypnum.

Phylum II. **PTERIDOPHYTA.** Ferns and Filicoid Plants.SUBPHYLUM A. STEREOCAULONES (= FILICES). SOLID-STEMMED
PTERIDOPHYTES.

Class III. PTERIDINEÆ (Filicineæ). Ferns and Allies.

ORDER V. PTERIDALES (Filicales). THE FERNS.

Family 19. POLYPODIACEÆ. Fern family.

Onoclea.
Woodsia.
Cystopteris.
Polystichum.
Dryopteris.
Camptosorus.
Asplenium.
Adiantum.
Pellaea.
Cheilanthes.
Notholaena.
Polypodium.

ORDER VI. OPHIOGLOSSALES. THE ADDER-TONGUES.

Family 20. OPHIOGLOSSACEÆ. Adder-tongue family.

Ophioglossum.
Botrychium.

ORDER VII. HYDROPTERIDALES. THE WATER FERNS.

Family 21. SALVINIACEÆ. Floating-fern family.
Azolla.

Family 22. MARSILEACEÆ. Water-fern family.
Marsilea.

ORDER VIII. ISOETALES. THE QUILLWORTS.

Family 23. ISOETACEÆ. Quillwort family.

SUBPHYLUM B. ARTHROCAULONES. JOINT-STEMMED PTERIDOPHYTES.

Class IV. EQUISETINEÆ. Joint-rushes.

ORDER IX. EQUISETALES. THE HORSETAILS.

Family 24. EQUISETACEÆ. Horsetail family.
Equisetum.

SUBPHYLUM C. LEPIDOCAULONES. SCALY-STEMMED PTERIDOPHYTES.

Class V. LYCOPODINEÆ. Club-mosses.

ORDER X. SELAGINELLALES. THE LITTLE CLUB-MOSSES.

Family 25. SELAGINELLACEÆ. Ground-fir family.
Selaginella.

Subkingdom II. ARCHEGONIATA.

Archegoniate Spore-Bearing Plants.

Ærial, terrestrial, moisture-loving, chlorophyl-developing plants, generally small, with a well-defined "alternation of generations," being in reality the different stages or phases of a cycle of life.

One is an *oöphoral*, or ovum-bearing, stage, called *gametophyte*. This is the final stage in the life cycle of a plant; though in the archegoniates it appears to be the first. In this stage the plants, entirely cellular and with or without chlorophyl, so differ that some of the plants, when diœcious, bear *antheridia*, or antheridial sacs, which carry till they ripen many antheridial bodies called *antherozoïds* or *spermatozoïds*, minute specialized bodies, endowed with the power of voluntary motion under water, that take part in the reproduction of their own species under certain fixed conditions; others of the plants bear what are called *archegonia*, sacs containing a single oöidal cell or *oösphere*, which, on being impregnated by fusion with it of an antherozoid from an antheridial plant, clothes itself with a cell wall and becomes an *oöspore*. When monœcious, both kinds of reproductive bodies are borne on the same plant; and the process gone through with is precisely the same. The derived oöspore is either a fertile thin-walled cell ready to germinate at once, or is a thick-walled cell analogous to a seed and must pass through a formative period of rest before germinating; then, conditions being favorable, may develop into a liverwort, a moss, a fern, or a horsetail, exactly as the parent plants were. The process is called *oögary*; the minute functional bodies are called *gametes*.

The other is a *sporophoral*, or spore-bearing, stage, called *sporophyte*. It is a direct product of the oöspore; and is a plant in which reproductive bodies are not developed, but which is capable for a time of multiplying vegetatively, and finally of bearing nonsexual spores in uncountable numbers, any of which, falling in a suitable place, and conditions being favorable, may develop into and produce the oöphores, or *gametophytes*, as before.

This is the natural process of all creation. "The child is father to the man" is a very old and well-established saying. The man, we know, is fa-

ther to the child. We have yet to learn of a man being father to a man like himself without the young man's first passing through the formative period of childhood. The passing of a youthful sporophyte into a numerously represented adult gametophyte through the intervention of a multitude of spores is one of the important differences between plant life and animal life. The feature belongs distinctively to plant life and is not to be explained by anything in animal life, which is an entirely different kingdom.

In all archegoniates creation is indeterminate. Only enough of the plant is organized in the oöspore to start the sporeling on a good, healthy growth. Creation, though it necessarily precedes, is continuous with development, as distinctly seen in the coil of the fern frond. Yet there is a limit to creation and development. Food supply, gravity and strength of materials, season, temperature, etc., are all barriers that limit growth.

There are two main phyla of this subkingdom, namely: (i) *Bryophyta*, or mosses and liverworts, and (ii) *Pteridophyta*, or ferns, horsetails and club mosses.

Phylum I. BRYOPHYTA (Muscineæ).

Mosses and Liverworts.

Chlorophyl-developing, nonsaprophytic, nonparasitic, cellular plants, usually small, rarely exceeding 10 cm. in height, often no more than one millimeter, germinating in moist, damp or wet places, and consisting of green, prostrate or erect stems and branches of various forms, with or without rudimentary leaves.

Gametophytes, which are conspicuous and comparatively long-lived, develop from a spore, and may multiply vegetatively by minute budlets (gemmæ), by offshoots (innovations), or by runners. Antheridial or archegonial bodies, or both, are later formed on the main stem or branches. These give rise to new forms (sporophores) situated upon them, that finally bear asexual spores as in the beginning. All phases of life are cellular; the sporophores, which are only parts of plants after all, like the stalked capsule of a carpellate plant, are never a separate generation, but are stationed on top of the oöphoral or gametophytic plants and depend upon them for existence.

The fruit-bearing bodies are (a) *antheridia*, which are simple, club-shaped, sperm-bearing organs, in which each antheridium bears numerous cells, each of which contains a single spirally-curved biciliated sperm or antherozoid; and (b) *archegonia*, flask-shaped bodies, each of which contains a single ovum or oöid cell at the bottom. Fecundation takes place under water by the antherozoids swimming to the summit of the archegonium and working their way down the narrow channel in its neck to the ovum at the bottom, with which one of the antherozoids, and one only, fuses. Rain, heavy dew or melting snow provides sufficient water for this purpose.

After impregnation the ovum germinates immediately and gives rise to a stalked spore-case (the sporophore) which contains very many nonsexual spores, any of which on escaping may develop into a nonchlorophyl-bearing thallus or protonema, from which the oöphoral liverworts or mosses later arise by budding.

There are two classes in this phylum, namely: (i) *Marchantineæ*, or liverworts, and (ii) *Bryineæ*, or mosses in general.

Class I. **MARCHANTINEÆ** (Hepaticæ).*Liverworts.*

Prostrate bilateral chlorophyllose cellular thalloid creeping stems and branches, with or without a midvein; otherwise a filiform axis with two rows of rudimentary leaves having no midvein. Plants with two distinct surfaces, an upper, or dorsal, which develops the chlorophyl, and an under, or ventral surface, which bears the rhizoids or root hairs. Reproduction is by antheridia and archegonia in, on, or peduncled above, the dorsal surface of the thallus. The impregnated archegonium develops into a sporophore or spore-bearing capsule, sometimes called a *sporogonium*.

ORDER I. **MARCHANTIALES**: THE THALLOID LIVERWORTS.

Oöphores flat, prostrate, dorsiventral, radiate, dichotomously branching, chlorophyllose thalli, two plates of cells or more in thickness, and one or more centimeters in breadth, floating on quiet waters or growing on wet earth. Antheridia and archegonia imbedded in the surface of the thallus, the archegonia in flask-shaped cavities, none of which open till the antherozoids and ova are mature, the one to escape, the other to be impregnated.

Sporophores club-shaped or globose bodies, sessile or stalked upon the oöphores, after impregnation of the ova, and developing in the sporophyls many asexual spores, usually without columella or elaters.

Family 1. **RICCIACEÆ**: Crystalwort Family.

1. *Riccia frostii* Austin. Wet sands near river, Kaw valley; common. (S)
2. *Riccia lescuriana* Aust. Damp rocky ground, eastern Kansas; frequent. (S)
3. *Riccia crystallina* Linnæus. Mud flats, near Kaw river, etc.; common. (S)
4. *Riccia fluitans* L. Stagnant pools and wet mud flats; common.

Family 2. **MARCHANTACEÆ**: Liverwort Family.

5. *Marchantia polymorpha* L. Damp ground, N. and E. K.; not common, but occasionally seen. (A S U)
6. *Preissia commutata* Nees. Damp shales, E. K.; common. (S)
7. *Fimbriaria tenella* Nees. Damp ground, S. E. K.; not common. (S)
8. *Conocephalus conicus* Dumortier. Shady banks, forming mats; common. (S)
9. *Asterella hemisphærica* Beauvois. On the ground, E. K.; frequent. September. (S)

Family 3. **ANTHOCEROTACEÆ**: Hornwort Family.

10. *Anthoceros laevis* L. Wet clay banks, along creeks, E. K.; frequent. (S)
11. *Anthoceros punctatus* L. Wet banks, E. K.; common. Elaters present.
12. *Notothylas orbicularis* Sullivant. Wet places, S. E. K.; occasional. Elaters not manifest.

ORDER II. JUNGERMANNIALES: THE SCALE MOSSES.

Liverwort-like plants, with a central prostrate stem and two lateral rows of leaves, usually crowded and overlapping, with sometimes a third row of smaller scales on the under side. Antheridia and archegonia may be on different plants (dioecious), on different branches of the same plant (monœcious), or mingled in the same flowers (synœcious).

Family 4. JUNGERMANNIACEÆ: Scale-moss Family.

13. *Frullania virginica* Lehmann. On bark of trees, E. K.; frequent.
14. *Frullania squarrosa* Nees. Rocks and bark of trees, E. K.; frequent. (S)
15. *Lejeunea clypeata* Sull. Rocks and base of trees, E. K.; common. (S)
16. *Ptilidium ciliare* Nees. Rotten log and stumps; common. (S)
17. *Lophocolea minor* Nees. Limy soil and limestone rocks, E. K.; occasional.
18. *Lophocolea heterophylla* Nees. Rotten logs in shady woods, E. K.; occasional. (S)
19. *Chiloscyphus adscendens* Hooker & Wilson. Rotten logs; rather common. (S)
20. *Chiloscyphus polyanthos* Corda. Damp ground among moss or on rotten logs.
21. *Jungermannia schraderi* Martius. On the ground and on rotten logs.
22. *Fossombronina angulosa* Raddi. Salt marshes, C. K.; frequent. Early spring. (S)
23. *Pallavicinia lyellii* S. F. Gray. Among moss on damp rocks, Franklin county. (S)
24. *Pellia calycina* Nees. Wet shales and limestone; occasional.
25. *Aneura latifrons* Lindberg. On rotten logs; frequent.

Class II. BRYINEÆ (Musci.)

Mosses.

Plant-body (gametophyte) a leafy stem, usually erect, developing root-hairs (rhizoids) below and leaves above at right angles to the stem. Leaves consist of a single layer of cells, usually with a delicate midnerve. The round of life in the mosses begins with the spore formed in the capsule. From the spore is developed a protonema, which is a filamentous, pluricellular, usually chlorophyllose, always nonsexual, structure, upon which arises by budding the oöphore, which is the ordinary moss as we see it, and which bears, on its summit or in its axils, the flowers and reproductive bodies, the antheridia and archegonia, from which latter arise the capsules of spores (sporophores), usually on long stalks. The flowers may be synœcious, monœcious, or dioecious.

Mosses are not abundant in Kansas; some of the orders are not represented at all. There are only two orders, *Phascales* and *Bryales*, usually regarded as belonging to the one order, *Bryales*.

ORDER III. PHASCALES: THE SAC MOSSES.

Plants very low, scarcely more than a mere bud upon a filiform prothallium developed from a spore. Leaves clustered, soft and thin, sometimes nerved. Flowers either synœcious, monœcious, or pseudodioecious. Capsule globose, subsessile, or short-pedicel, with a columella and a true foot, indehiscent (*cleistocarpous*), the spores escaping only upon its disintegration.

Family 5. MICROMITRIACEÆ: Micromitrium Family.

26. *Ephemerum spinulosum* Bruch & Schimper. Moist clay ground, E. K.; common. (S)

Family 6. PHASCACEÆ: Phascum Family.

27. *Phascum carniolicum* Weber & Mohr. Sandy ground, and stones on the plains of W. K. (Lesquereux & James, Mosses of N. A., p. 42.)
 28. *Phascum cuspidatum* Schreber. Dry soil, along fences, etc., E. K.; occasional. (Eugene Rau, in Bulletin of Washburn Laboratory of Natural History, i, p. 172.)
 29. *Pleuridium bolanderi* Mueller. Damp ground, Saline county. (Renauld & Cardot, in *Botanical Gazette*, xvii, p. 82.)
 30. *Microbryum floerkeanum* Schimper. Sandy soil, Saline county; rare. (R. & C., Bot. Gaz., xiv, 91.)

Family 7. ARCHIDIACEÆ: Archidium family.

31. *Archidium hallii* Austin. Reported from Saline county by Dr. Joseph Henry and listed by Miss Reed in Transactions Kan. Acad. Sci., xiv, 164.)

ORDER IV. BRYALES: THE TRUE MOSSES.

Plants (gametophytes) low and tufted, seldom exceeding 10 cm. high, from a filiform prothallium. Leaves sessile and several-ranked, consisting of a single layer of chlorophyllose polygonal areolæ, with a midnerve of elongated cells. Flowers inclosed in perichætal leaves. Reproductive bodies terminal or lateral; archegones one or several to a flower, each developing into a stalked spore-case or capsule (sporophore), which has a columella in its center, and dehisces transversely near the top, leaving a small lid (operculum) like a little brownie cap, above. Mouth of the capsule (peristome) usually provided with one or two rows of slender hygroscopic teeth, either 4, 8, 16, 32 or 64 in the outer row; lid covered with a calyptra, like a minute, long-pointed lamp-flame extinguisher. There are two suborders according to whether the flowers (*a*) are on the ends of the stem and branches (*Acrocarpi*) or (*b*) are in the axils of the leaves (*Pleurocarpi*).

Suborder A. ACROCARPI: Capsules Terminal.

Flowers terminal, becoming lateral by innovations from under the flowers.

Family 8. DICRANACEÆ: Dicranum Family.

32. *Astomum crispum* Hampe. Sandy soil, Saline county. (R. & C., Bot. Gaz., xvii, 82.)

ORDER IV. CRYACES: THE TRUE MOSSES.

Suborder A. *ACROCARPI*: *Capsules Terminal*.

Family 8. DICRANCEÆ: Dicranum Family.

33. *Astomum sullivantii* Schimp. Meadows, Saline county. (R. & C., l. c.)
34. *Gymnostomum rupestre* Schwaegrichen. Shaded overhanging rocks, Riley and Pottawatomie counties. (Miss M. Reed, Trans. Kan. Acad. Sci., xiv, 168.)
35. *Weisia viridula* Hedwig. Sandy ground, E. K., as far west as Salina; frequent. (S)
36. *Dicranella varia* Schimp. Damp banks, E. K.; common. (S)
37. *Dicranella heteromalla* Schimp. Clay banks, E. K.; frequent. (Rau, Washb. Bull., i, 172.)
38. *Dicranum scoparium* Hedwig. Sandy ground, E. K., west to Salina and Barton; frequent. (S)
39. *Dicranum fuscescens* Turner. Old logs, E. K.; frequent.
40. *Campylopus henrici* Cardot. Sandy ground, Saline county; not common. (R. & C., Bot. Gaz., xiii, 198.)
41. *Fissidens bryoides* Hedw. Shaded ground, Saline county. (Rau, Washb. Bull., i, 172.)
42. *Fissidens obtusifolius* Wilson. Damp ground, E. K.; frequent. (S)
43. *Fissidens kansanus* Ren. & Card. Wet sandstone rocks, Saline county. (R. & C., Bot. Gaz., xv, 40.)
44. *Fissidens osmundoides* Hedw. On ground, N. E. K.; frequent. (S)
45. *Leucobryum vulgare* Hampe. Damp places in woods, E. K.; common. February. (S)
46. *Ceratodon purpureus* Brid. Common and very variable. (S)

Family 9. POTTIACEÆ: Pottia Family.

47. *Pottia subsessilis* B. & S. On clayey ground, stone walls, etc., Saline and Shawnee. (M. Reed, Trans. K. A. S., xiv, 170.)
48. *Didymodon rubellus* B. & S. On ground near water, E. K. (S)
49. *Leptotrichum vaginans* Lesq. & James. Clayey soils, E. K. (S)
50. *Leptotrichum pallidum* Hampe. Clayey soil, Saline, Wilson, Labette counties. (Rau, W. B., i, 172.)
51. *Barbula unguiculata* Hedw. Damp, black soil, along fences, etc., E. K.; very common and variable. (S)
52. *Barbula cæspitosa* Schwæg. Roots of trees in grassy places, Wabaunsee and Saline counties; frequent. October. (Rau, W. B., i, 61.)

Family 10. GRIMMIACEÆ: Grimmiæ Family.

53. *Grimmia apocarpa* Hedw. Damp rocks, walls, etc., middle and western Kansas. (Rau, W. B., i, 172.)
54. *Coscinodon wrightii* Sull. Rocks in S. W. K., northeastward to Salina. (R. & C., Bot. Gaz., xv, 41.)

ORDER IV. BRYALES: THE TRUE MOSSES.

Suborder A. ACROCARPI: Capsules Terminal.

Family 10. GRIMMIACEÆ: Grimmiæ Family.

55. *Coscinodon renauldii* Card. Saline county; not known from elsewhere. (R. & C., Bot. Gaz., xv, p. 41, pl. VIb.)
56. *Ptychomitrium pygmæum* L. & J. On stones in Neosho river; occasional. (L. & J., Proc. Amer. Acad., xiv, 136.)
57. *Orthotrichum cupulatum* Hoffmann. Limestone rocks, E. K.; variable but not common. (S)
58. *Orthotrichum strangulatum* Beauvois. On trees, Saline county; not common. (Rau, W. B., i, 172.)

Family 11. FUNANIACEÆ: Funaria Family.

59. *Pyramidula tetragona* Brid. Sandy soil, Barton to Saline (Henry). (S)
60. *Physcomitrium pyriforme* Brid. Wet open and shaded ground; common. Fruits in spring. (Rau, Washb. Bull., i, 18, 114.)
61. *Physcomitrium hookeri* Hampe. Meadows, Riley county (Kellerman).
62. *Physcomitrium acuminatum* B. & S. Moist earth, chalk region, N. W. K. (Carleton); also Wyandotte county (Reed); occasional. (Rau, W. B., i, 172.)
63. *Physcomitrium kellermani* Mrs. Britt. Moist sandy banks, near streams, Riley, Wabaunsee, Pottawatomie, Wyandotte, Phillips counties. (Mrs. Eliz. G. Britton, Bull. Torr. Bot. Club, xxi, 204.) Differs from *hookeri* in its smaller size, flaring mouth and single annulus.
64. *Funaria hygrometrica* Sibthorpe. Bare ground, moist sand and rocks, chinks of a well wall at Topeka, etc.; very common. (S)

Family 12. BRYACEÆ: Bryum Family.

65. *Bartramia pomiformis* Hedw. Shady banks and fissures of rocks, S. E. K.; occasional. (Rau, W. B., i, 114.)
66. *Leptobryum pyriforme* Schimp. Shaded sandy ground, E. K.; frequent. (S)
67. *Webera annotina* Schwaegr. Banks, Shawnee county. (Bull. Washb. Coll., i, 61.)
68. *Webera albicans* Schimp. Wet sand, E. K.; frequent. (S)
69. *Bryum pendulum* Schimp. On the ground and decayed trees; common. Capsule narrow-mouthed; lid acutely apiculate. (S)
70. *Bryum bimum* Schreb. South side of a well, Topeka. (Cragin, Washb. Bull., i, 114, 173.)
71. *Bryum argenteum* L. Sandy ground, etc., E. K.; common. (S)
72. *Bryum caespitium* L. On ground, old walls, etc., E. K.; common. Capsule wide-mouthed; lid large, mammiform; peristome ferruginous. (M. Reed, Trans. K. A. S., xiv, 175.)

ORDER IV. BRYALES: THE TRUE MOSSES.

Suborder A. ACROCARPI: Capsules Terminal.

Family 12. BRYACEÆ: Bryum Family.

- 73. *Bryum ontariense* Kindberg. Old logs, sometimes on limestone rocks, Saline county; rare in Kansas. (M. Reed, Trans. K. A. S., xiv, 175.)
- 74. *Mnium cuspidatum* Hedw. Shaded places on the ground, E. K.; very common. (S)
- 75. *Mnium affine* Bland. Shaded banks or roots of trees, E. K.; very common. (Rau, Washb. Bull., i, 61, 173.)
- 76. *Mnium elatum* (B. & S.) Ground and shaded banks, E. K.; occasional.
- 77. *Timmia megapolitana* Hedw. Wet shaded banks, in woods, Shawnee, Riley and Pottawatomie counties; occasional. (S)

Family 13. POLYTRICHACEÆ: Polytrichum Family.

- 78. *Atrichum undulatum* Beauv. Sandy ground, in woods; not common. (Rau, Washb. Bull., i, 172.)
- 79. *Atrichum altecristatum* (R. & C.). Sandy ground, Saline county; not common.
- 80. *Atrichum angustatum* B. & S. Dry woods and gravelly soil; very common. (Rau, Washb. Bull., i, 18, 62.)
- 81. *Atrichum xanthopelma* L. & J. Saline (Henry), Riley and Wyandotte. (M. Reed, Trans. K. A. S., xiv, 176.)
- 82. *Polytrichum juniperinum* Willdenow. Barren plains, W. K., and Pottawatomie county. (M. Reed, *l. c.*)

Family 14. FONTINALACEÆ: Fontinalis Family.

- 83. *Fontinalis*, sp. indet. In springs near Deep creek, Franklin county (Miss Meeker). (S)
- 84. *Fontinalis dalecarlica* B. & S. Pottawatomie county. (M. Reed, Trans. K. A. S., xiv, 176.)

Suborder B. PLEUROCARIPI: Capsules Axillary.

Fruit lateral; antheridial and archegonial flowers sessile in the axils of the leaves, either on the main stem or branches.

Family 15. NECKERACEÆ: Neckera Family.

- 85. *Meteorium nigrescens* Mitten. Riley county. (Reed, Smyth's Ch.-L., Supp., p. 36.)

Family 16. FABRONIACEÆ: Fabronia Family.

- 86. *Fabronia octoblepharis* Schwaegr. Saline county. (Reed, Tr. K. A. S., xiv, 176.) Peristome of 8 geminate dark brown teeth, bifid only when old.

Family 17. LESKEACEÆ: Leskea Family.

- 87. *Thelia asprella* Sull. Base of trees; frequent in E. K. November. (S)
- 88. *Leskea polycarpa* Ehrhart. On clay and limestone and foot of trees, N. and E. K. October. (S)
- 89. *Leskea obscura* Hedw. Base of trees in low grounds reached by floods, E. K.; frequent. (S)

ORDER IV. BRYALES: THE TRUE MOSSES.

Suborder B. PLEUROCARPI: Capsules Axillary.

Family 17. LESKEACEÆ: Leskea Family.

90. *Leskea austini* Sull. Trunks of trees, general in E. K.; quite common. (S)
91. *Anomodon rostratus* Schimp. Base of trees in woods, E. K.; occasional. October. (Rau, Washb. Bull, i, 61.)
92. *Anomodon attenuatus* Huebener. On mud deposited by floods, E. K., along rivers. (Rau, *ibid*, 173.)
93. *Anomodon obtusifolius* B. & S. Trunks of trees, near watercourses, E. K. (S)
94. *Pylaisia intricata* B. & S. Trees and old logs, Jefferson and Shawnee counties; frequent. (S)
95. *Pylaisia velutina* B. & S. Bark of trees, Riley, Wabaunsee and Shawnee counties; frequent. (S)
96. *Entodon cladorrhizans* C. Muell. (*Cylindrothecium* B. & S.) Decayed logs and on the ground, E. K.; common. (S)
97. *Entodon seductrix* C. Muell. (*Cylindrothecium* B. & S. Prostrate logs in moist shaded places, E. K.; common. (S)
98. *Entodon compressus* C. Muell. (*Cylindrothecium* B. & S.) Roots of trees near watercourses, E. K.; frequent. (S)
99. *Climacium americanum* Brid. Rotten logs in thickets, Shawnee county. (Dr. G. N. Best, Rosemont, N. J.) (S) Resembles *C. dendroides*.

Family 18. HYPNACEÆ: Hypnum Family.

100. *Thuidium gracile* B. & S. Decayed logs in shady woods, Shawnee county; quite common. (Dr. Best, Smyth's Ch.-L., Supp., p. 36.) (S)
101. *Thuidium recognitum* (Hedw.) Lindb. On ground, shade of trees, E. K.; very common. June. (R. & C., Bot. Gaz., xvii, 82.)
102. *Thuidium abietinum* (L.) B. & S. Barren ground bordering woods, Bourbon county. (M. Reed, Trans. K. A. S, xiv, 178, 180.)
103. *Brachythecium lætum* (Brid.) B. & S. Dead logs in damp woods, E. K.; common. December. (S) A very variable species.
104. *Brachythecium acuminatum* (Hedw.). On ground in woods, general in E. K.; very common. October. Dark green. (S)
104. *Brachythecium setosum* (S. & L.) (*Leskea setosa* Hedw.) Decayed logs in open woods, Shawnee county; apparently common. Pale yellow; capsule erect, straight; lid long-acuminate; peristome without cilia. November. (S) Undoubtedly a mere variety of the preceding species, differing in form, color, size, etc., as variations are expected to differ.
106. *Brachythecium acutum* Sull. Decaying tree trunks and similar places, Shawnee county. November. (S)

ORDER IV. BRYALES: THE TRUE MOSSES.

Suborder B. *PLEUROCARPI*: Capsules Axillary.

Family 18. HYPNACEÆ: Hypnum Family.

107. *Brachythecium rutabulum* (L.) B. & S. Shaded ground, etc., Shawnee county. (S)
108. *Brachythecium rivulare* B. & S. Wet ground in woods, Saline and Wyandotte counties; frequent in places. Dioecious. (Rau, W. B., i, 173.)
109. *Brachythecium plumosum* (Swartz) B. & S. Subaquatic; moist rocks by the Shunganunga, Shawnee county. Monoecious. (Rau, *l. c.*, i, 18, 173.)
110. *Eurhynchium strigosum* (Hoffm.) B. & S. Shaded sandy ground, Wabaunsee county. (*Ibid.*, 114.)
111. *Eurhynchium hians* (Hedw.). Woods, Shawnee county; common. (S)
112. *Rhynchostegium geophilum* Aust. Wilson county (McClung). (Reed, Trans. K. A. S., xiv, 178, 180.)
113. *Rhynchostegium serrulatum* (Hedw.). On the ground, in dry woods, Jefferson and Shawnee counties. (Rau, W. B., i, 18.)
114. *Rhynchostegium rusciforme* Weis. Stones in rapid-running water, Shawnee county. (S)
115. *Plagiothecium denticulatum* (L.) B. & S. Decayed trunks in shady woods, E. K.
116. *Plagiothecium sylvaticum* (Huds.) B. & S. Clayey ground in woods, Saline county. (Rau, W. B., i, 173.)
117. *Amblystegium confervoides* (Brid.) B. & S. Moist shaded limestones, Rooks county. (Reed, Trans. K. A. S., xiv, 178, 180.)
118. *Amblystegium serpens* (L.) B. & S. Decayed wood in moist shady places, E. K.; frequent. (S)
119. *Amblystegium radicale* (Beauv.) B. & S. Wet ground and decayed trunks in shade, Riley county (Reed); Shawnee county; frequent. (S)
120. *Amblystegium orthocladon* (Beauv.). On the ground in springy places, C. and E. K.; common. (Reed, Trans. K. A. S., xiv, 178, 180.)
121. (?) *Amblystegium irriguum* (Hook. & W.). Riley county. (*Ibid.*)
122. *Amblystegium fluviatile* (Swz.) B. & S. Rocks in a well-wall, Riley county. (*Ibid.*)
123. *Amblystegium adnatum* (Hedw.). On stones or on the base of trees in shady woods, Saline, Riley; said to be common. (*Ibid.*)
124. *Amblystegium porphyrrizon* Lindb. Saline and Wyandotte. (R. & C., Bot. Gaz., xiv, 99.)
125. *Amblystegium riparium* (L.) B. & S. Stones, in water, northeastern and central Kansas. (Rau, Washb. Bull., i, 114.)
126. *Amblystegium cariosum* (Sull.). Saline county. (*Ibid.*, 172.)
127. *Amblystegium serratum* (R. & C.). Roots of trees, C. K. (R. & C., Bot. Gaz., xiv, 98.)

ORDER IV. BRYALES: THE TRUE MOSSES.

Suborder B. *PLEUROCARPI*: Capsules Axillary.

Family 18. HYPNACEÆ: Hypnum Family.

128. *Amblystegium kochii* Schimp. C. K. (Husnot, *Muscologia Gallica*, p. 362.)
129. *Campylium hispidulum* (Brid.) Mitten. On the ground in damp woods, E. K.; frequent. (Rau, W. B., i, 61.)
130. *Campylium chrysophyllum* (Brid.). On the ground, decaying trunks of trees, etc., S. E. K. (*Ibid.*, 114.)
131. *Harpidium aduncum* (Hedw.), var. Damp ground, Saline county. (*Ibid.*, 173.)
132. *Hypnum curvifolium* Hedw. Decayed and decaying logs in shady woods, Shawnee county. Abundant in spots. (S)

Phylum II. PTERIDOPHYTA.

Fernworts and Filicoid Plants.

Vascular plants, aërial, terrestrial, rarely aquatic, living two or more well-marked phases or conditions of life, namely:

(a) A *pteral* or sporophoral stage, conspicuous and long-lived, called sporophyte, in which the plants have erect annual stems and sporophores from perennial horizontal stems or rootstocks, all with well-developed fibro-vascular tissues. They bear, in specially constructed multicellular receptacles called sporangia, vast numbers of asexual spores, which may be of two kinds: (a) minute and all alike, in which case the plants are called *homosporous*; or (b) of two sizes, called *microspores* and *megaspores*, or *androspores* and *gynospores*, in which case the plants are called *heterosporous*. These nonsexual spores may, under certain favorable conditions, germinate and produce:

(b) A *prothallial*, or oöphoral stage, quasi-sexual, short-lived, and inconspicuous, called *gametophyte*, on which are developed the reproductive bodies, sometimes on the same and again on separate plants. This is a nonvascular thalloid growth, whose sole purpose in life seems to be the production of *oöspores*, minute bodies containing the germ of a future plant within and a hard cell wall or protecting case of cellulose without, and requiring that a long period of apparent rest be given to it before conditions are favorable for its germination. During this period the plant life within the cell is capable of withstanding extreme conditions of temperature and desiccation that would be fatal to active life. Indeed, it is often even necessary that the oöspore should pass through extreme vicissitudes before it will germinate.

(c) An *oösporal* stage, which is after all really the first stage in the life of a filicoid, and is just as essential as the two forms under consideration, the *pteral* being the second or principal stage, and the *prothallial* stage the final.

From the microspores are developed antheridial prothallia, bearing on the under or ventral surface *antherids* only; from the megaspores are developed archegoniate prothallia, which bear also on their under surface small sacs, each containing an archegonial cell or *oösphere* (ovum), ready to be impregnated by an antherozoid.

These antherozoids are microscopic spiral sperms, provided with two or more long cilia (sensitive muscular flexible hairs) by means of which they propel themselves through the water to the oöspere.

Fertilization must take place under water, as in a drop of dew or rain, which is usually ample. The oöspere in the archegonial plant, after fecundation, becomes an oöspore, a globular body analogous to a seed, which, when in a place adapted to its growth, after its period of rest (formative period) is ended, may develop and grow into a spore-bearing plant (a sporophyte), as at first.

There are three general subdivisions of these plants: (a) Those which in the sporophytic stage have solid stems, few highly developed leaves, and a moderately developed sporophore system; in the gametophytic stage they have a very primitive reproductive system (ferns). (b) Those which in the sporophytic stage have tubular jointed stems, rudimentary leaves, and a more complex and highly developed sporophore system; in the gametophytic stage they have a somewhat primitive reproductive system (horsetails). (c) Those which in the sporophytic stage have solid stems, very many minute simple leaves, and a highly developed sporophore system; and in the gametophytic stage have a more highly developed and more occult reproductive system (club mosses).

Subphylum A. STEREOCAULONES (Filices.)

SOLID-STEMMED PTERIDOPHYTES.

Archegoniate plants, in which the sporophytes have stems and leaves without large cavities, and in which the closed bundles of fibrovascular tissue are firm and continuous from end to end without articulation, but with the bifurcation necessary to produce increase of surface.

There are several classes, but only one represented in Kansas, unless Isoëtes be regarded as a separate class.

Class III. PTERIDINEÆ (Filicineæ).

Fernworts.

Plants which in the pteral or sporophyte stage have solid horizontal stems, erect sterile and spore-bearing leaves (fronds), and well-developed roots. The fronds are circinate or coiled in pefoliation and usually have dichotomous nervation. In the gametophyte stage the plants are small, flat, green, cellular prothallia, on the under surface of which the fruit-bearing bodies, antheridia and archegonia, are borne; in a few cases the gametophytes are enclosed in small globose bodies (sporocarps) which remain and develop on the sporophores, thus simulating seeds.

There are four subclasses, and four orders in Kansas coterminous with them, one order to each subclass, based according to whether the sporangia are developed on the surface of a frond (*leptosporangiate*) or are deep-seated (*eusporangiate*), and according to whether the spores borne by any sporophytic plant are all of one size (*homosporous*) and the resulting oöphores are monœcious; or whether the spores are of two sizes, as microspores and megaspores, in which case the sporophores are *heterosporous* and the resulting oöphores are diœcious. These four subclasses cross each

other at right angles, two and two each way, as here shown, and cannot be arranged in a serial line except by combination, such as:

CLASS PTERIDINEÆ.

SUBCLASSES.	<i>Leptosporangiate.</i>	<i>Eusporangiate.</i>
HOMOSPOREÆ.....	Pteridales.....	Ophioglossales.
HETEROSPOREÆ.....	Hydropteridales.....	Isoetales.

ORDER V. PTERIDALES (Filicales): THE FERNS.

(*Homosporous Leptosporangiate Stereocaulones.*)

Sporophytes herbaceous, terrestrial, consisting of a firm, strong, vascular, creeping, hypogean stem (rhizome), from which arise several large, erect, long-stemmed leaves (fronds) of various forms, coiled in prefoliation, including one or more fertile ones (sporophores) which bear asexual spores in great numbers, minute and all alike. Laminæ of sterile fronds usually green on both sides; fertile fronds (sporophores) brown or brownish beneath. Sporangia (spore cases) stalked, developed normally from single epidermal cells and borne in clusters, called *sori*, along the veinlets or the margin, on the under side of the leaves or their segments, sometimes with a delicate membranous covering of special and various form called *indusium*. Sporangies each provided with a strong, elastic, multicellular ring or bar, which bursts on maturity of the spores and flies open, scattering the spores with considerable force.

Gametophytes (öophores) in the form of minute, two-lobed, green, flat, lichen-like expansions (*prothallia*) on the surface of the ground, produced from the spores, and which bear on their under surface the fruit-bearing organs, the antheridia and archegonia, both on the same plant (monœcious). In the bottom of each archegonium is a cellular sac containing a single ovum or large cell analogous to the embryo sac (ovulary) and ovule of the seed-bearing plants. The antheridia bear numerous multiciliated motile sperms, called *antherozoids*, which are to reach and impregnate or fertilize the ova in the archegonia. This process, which is one of the most important and necessary functions of life for the perpetuation of species, is ordinarily not seen, and would be wholly unknown without careful attentive observation and concentrated systematic study (peeping behind the curtains of nature, as it were). The öospore, when ripe, and conditions being favorable, may germinate and develop into a sporophyte similar to the original ancestor, and bear infinite numbers of nonsexual spores as before, thus completing the cycle of life.

There is only one family in Kansas.

Family 19. POLYPODIACEÆ: Fern Family.

133. *Onoclea sensibilis* L. Sensitive fern. Moist wooded banks along the Missouri river; infrequent. August. (A)
134. *Woodsia obtusa* Torr. Blunt-lobed *Woodsia*. Rocks and northern slopes in woods, northeast Kansas, west to Mitchell, south to Chautauqua; frequent. July. (A S U)
135. *Cystopteris fragilis* Bernhardt. Brittle fern. Rocky woods and shaded banks, N. E. K.; common. (A S U)

ORDER V. PTERIDALES (Filicales): THE FERNS.

Family 19. POLYPODIACEÆ: Fern Family.

136. *Polystichum acrostichoides* Schott. Christmas shield-fern. Rocky woods and northern hillsides, Neosho to Cherokee county; occasional. July. (A S U)
137. *Dryopteris noveboracensis* Gray. New York shield-fern. Woods, Doniphan county; not common. July. (S U)
138. *Dryopteris thelypteris* Gray. Marsh shield-fern. Ravines, Doniphan county; rare. June. (A S U)
139. *Dryopteris marginalis* Gray. Evergreen shield-fern. Crevices of rocks, S. E. K.; occasional; abundant in spots. July. (A S)
140. *Dryopteris intermedia* Gray. Glandular shield-fern. Damp woods, Wyandotte county; rare. July. (S)
141. *Camptosorus rhizophyllus* Link. Walking fern. Top of limestone bluffs, counties bordering on Missouri river, also in Wilson and Labette counties; occasional. (A S U)
142. *Asplenium parvulum* Martens & Galeotti. Little ebony spleenwort. Limestone bluffs, Montgomery county; rare. June. (A S)
143. *Asplenium platyneuron* Oakes. (*A. ebeneum* Aiton.) Chestnut spleenwort. Limestone banks, S. E. K., to Neosho county; rare. July. (A S)
144. *Asplenium acrostichoides* Swz. Silvery spleenwort. Rich, moist woods, Miami to Cherokee county; rare. August. (S)
145. *Adiantum pedatum* L. Maidenhair. Shady ravines and dense woods, E. K., west to Shawnee county; rare. July. (A S U)
146. *Pellaea atropurpurea* Link. Black cliff-brake. Clefts in north and northeastern faces of limestone bluffs, E. K., west to Ellsworth and Comanche counties; frequent. June, August. (A S)
147. *Cheilanthes lanosa* Watt. (*Ch. vestita* Swz.) Woolly lip-fern. Moss-covered rocks, Woodson county; rare. July. (S)
148. *Cheilanthes gracilis* Mettenius. (*Ch. lanuginosa* Nuttall.) Slender lip-fern. Sandstone bluffs; rare. Found years ago in Ottawa county, at "Rock City," by Mr. S. C. Mason, and in northern Barton, near Cow creek, by Mrs. D. J. Evans, both now in Washington, D. C. Not since reported, though likely to be found yet at other points in central Kansas. July. (A S U)
149. *Notholæna dealbata* Kunze. Calcimine fern; Silver cloak-fern. Crevices in northeastern faces of calcareous rocks and quartzite boulders, N. E. to S. E. Kansas; not readily found without attentive searching. June. (A S U)
150. *Polypodium polypodioides* Hitchcock. (*P. incanum* Swz.) Hoary polypody; Resurrection fern. Mossy bark of trees, S. E. K.; rare. July. (S)
151. *Polypodium vulgare* L. Rock polypody. Northeastern faces of limestone bluffs, Morris county; rare. June. (S)

ORDER VI. OPHIOGLOSSALES: THE ADDER TONGUES.

(*Homosporous Eusporangiate Stereocaulones.*)

Terrestrial herbaceous pteridophytes, with group-celled sporangia, in two rows, on the lateral edges of the sporangiophore, the walls many cells thick, transversely dehiscent.

Sporophytes having each an erect frond-bearing stem, with one portion (frond) adapted to chlorophyl work, another portion (sporophore) adapted to fruit bearing. Sporophores (special fronds or branches of fronds) bear spores all of one size (microspores) from bivalvular sporangia developed from clusters of epidermal and subepidermal cells in lieu of pinnæ along the margins of special fronds or frond branches (sporangiophores).

Gametophytes (oöphores) monœcious, tuberous, within the surface of the ground, devoid of chlorophyl, and said to be usually associated with a symbiotic fungus-mycelium, but whether with injury or benefit to the plant does not clearly appear. From oöspores within the oöphore body arise the young sporophytes, which for a time nurse upon the body of the oöphore, then cast root and become erect independent plants. This is the beginning of the erect stem in vascular plants and of differentiation between chlorophyl-developing leaf and fruit-bearing branch; and although the stem and leaves are only partially differentiated in the frond, yet it is a long step toward an erect woody plant.

There is but one family.

Family 20. OPHIOGLOSSACEÆ: Adder-tongue Family.

152. *Ophioglossum vulgatum* L. Adder-tongue. Moist meadows and thickets, E. K.; infrequent. May. (A S U)
153. *Botrychium virginianum* Swz. Rattlesnake fern. Hazel thickets and wooded hillsides, N. E. K., west to Council Grove; frequent. July. (A S U)
154. *Botrychium obliquum* Muhlenberg. (*B. ternatum* Swz.) Grape fern. Moist woods and hillsides, Doniphan, Atchison and Shawnee counties; rare. Sept. (S U)

ORDER VII. HYDROPTERIDALES: THE WATER FERNS.

(*Heterosporous Leptosporangiate Stereocaulones.*)

Aquatic pteridophytes with horizontal stems and erect leaves with the dichotomous nervation and circinate prefoliation characteristic of ferns, and with spores that produce oöspores without leaving the sporocarp. Sporocarps have short stalks and are borne on certain modified leaves called sporophyls. Here the gametophytes are more hidden than in any previous order of plants.

Sporophores bear dimorphous spores, from sporangia developed from single epidermal cells; the smaller size, called *androspores*, develop into minute rudimentary gametophytic prothallia upon which grow single antheridia; the larger, called *gynospores*, develop into small globular oöphores containing each an archegonium with its ovum, which remains attached to the sporophore. Fecundation is effected by an amœbic movement of the antheridial inner cell wall, in the form of a closed tube, which protrudes from the androspro-

ORDER VII. HYDROPTERIDALES: THE WATER FERNS.

carp and grows in the direction of a neighboring archegonium within its gynosporecarp, the tissues of which it penetrates after rupture of the outer wall; through this tube or tunnel the spermatozooids (antherozoids) pass to the ovum in the archegonium still within its sporocarp, which has ruptured its outer wall in order to allow of fertilization. This is another long step forward in the new mode of impregnation—a step that once taken is never afterward wholly abandoned, but pervades the fecundating mechanism of the entire carpellate subkingdom in the shape of a pollen tube. The mature oöspore, in a new protecting case which actually contains the entire archegonial gametophyte, in that respect resembling a seed, finally becomes separated from the parent sporophyte which may have perished, and, being in a suitable place, with all required conditions favorable, may germinate and grow into a new floating-fern or water-fern sporophyte. Thus this complicate process, commonly called “alternation of generations,” or heterogenesis, under such adverse conditions, is continually repeated. No wonder the plants are rare in Kansas. They require a humid climate and gentle movements of air and water. But the process of fecundation is adopted by nearly all the seed-bearing plants; plants that perform their breeding functions in air, not in water; plants that are better adapted to the surrounding conditions than the poor little water-ferns.

Although they are very rare, yet the few to be found in Kansas belong to two distinct families.

Family 21. SALVINIACEÆ: Floating-fern Family.

155. *Azolla caroliniana* Willd. Carolina floating-fern. Found in Cloud county by Professor Schaffner; also Burlington, Coffey county. (S)

Family 22. MARSILEACEÆ: Water-fern Family.

156. *Marsilea vestita* Hooker & Greville. Four-leafed water-fern. Wet or damp sandy hollows, such as old “buffalo wallows,” which dry in summer, Washington, Cloud, Saline, Barton and Greeley counties; rare. July. (A S U)

ORDER VIII. ISOËTALES: THE QUILLWORTS.

(*Heterosporous Eusporangiate Stereocaulones.*)

Pteridophytic plants in which the sporophores bear two forms and sizes of spores, namely, very small androspores bearing the antherozoids, and very large gynospores bearing the ova. These are all developed in sporangia formed from groups of epidermal and subepidermal cells. The antherozoids within the androspores are motile, microscopic, multiciliate, and spiral. A single ovum with its case (sporocarp) fills each gynospore.

Sporophytes with an erect, exceedingly short and comparatively broad stem or trunk, with a dense tuft of rootlets and no cauline leaves. This naked, button-shaped stem is crowned with a compact rosette of broad, erect sporophylls with excessively prolonged chlorophyl-developing tips, sometimes a decimeter high, resembling

ORDER VIII. ISOËTALES: THE QUILLWORTS.

rushes or grass leaves somewhat. The outer cycles of sporophylls bear in their axils or on their inner surfaces solitary gynosporangia, with spheroidal gynospores measuring one-fourth to three-fourths of a millimeter in diameter, with a reticulated surface, an equatorial ridge and three meridional ridges from the equator to the initial pole, making the entire spore resemble a low tetrahedron attached by its base to the flat side of a reticulated hemisphere. In the inner cycles each sporophyll bears a single androsporangium, carrying minute, obliquely oblong prismoidal androspores, 25 to 40 microns in diameter.

Gametophytes dioecious; those produced from the androspores are here very much reduced and are very minute, microscopic in fact, and parasitic, each bearing but a single antheridium; the archegonial gametophytes, those produced from the gynospores, after fecundation of the ova, become small globular bodies developing within the sporophyte gynospore wall and not escaping therefrom, the wall being ruptured only to allow access of antherozoids. This is yet another long step toward the development of the seed-bearing plants. Indeed the resemblance of the quillwort to a seed-bearer is very strong; it is frequently mistaken for a grass or a sedge, else it might oftener be recognized as a quillwort. This eusporangiate-heterosporous combination is the one that pervades the entire carpellate subkingdom. It has proven effective in plants that breed in air, even more so than those that breed in water, and is never afterward wholly abandoned.

There is but the one genus, *Isoëtes*, in this anomalous order of Isoëtales, placed here for convenience without any claim that it belongs here more than elsewhere. The real truth is, it has fern and horsetail characteristics in its spiral multiciliate antherozoids, horsetail characteristics in the verticillate arrangement of its leaves, and club-moss characteristics in its solitary sporangia and the form of its gynospores. It differs from the stereocaulones in the form of its leaves and in its mode of fruit-bearing; from the arthrocaulones in being stemless and in its mode of spore-bearing; and differs from the lepidocaulones in having verticillate leaves and in its sperms being multiciliate instead of biciliate.

Family 23. ISOËTACEÆ: Quillwort Family.

157. *Isoëtes butleri* Engelm. Butler's quillwort. Cherokee county (Hitchcock). (A)
158. *Isoëtes melanopoda* J. Gay. Black-based quillwort. Greeley county, in a shallow, clay-bottomed, water-holding, often dry basin west of Horace; rarely seen and recognized. Sept. (S)

Subphylum B. ARTHROCAULONES (*Equisetæ*).

JOINT-STEMMED PTERIDOPHYTES.

Archegoniate plants in which the sporophytes have tubular or hollow stems, with articulations or joints at intervals along the stem. There is only one class.

Class IV. EUISETINEAE: Joint Rushes.

Erect, hollow, jointed and banded sporophytes, having a fluted or clustered-columnar structure, with solid nodes and whorled rudimentary leaves, arising from perennial, horizontal, hypogean stems or "rootstocks." The sporangia (spore-pockets) on the under side of the sporophylls, in a cone at the summit of a sporophore, develop from a cluster of epidermal and subepidermal cells (eusporangiate), and the spores are all of one size (microspores), each furnished with two strap-like hygroscopic appendages, attached by the middle, that coil close around the spore when moist, and uncoil when dry. In this class of plants the cone is adopted as a method of fructification, a system that reaches its greatest perfection in the Coniferæ, but is considerably modified in other classes.

ORDER IX. EUISETALES: THE HORSETAILS.

(Homosporous Eusporangiate Arthrocaulones.)

Sporophytes semiaquatic or terrestrial, herbaceous, with uniform spores which develop into irregularly-lobed green prothallia (oöphytes) on the surface of the ground. These prothallia are dioecious; some bear fertile antheridia, carrying spiral multiciliate antherozoids, somewhat like those of the quillworts; others bear flask-shaped archegonia, each with a single ovum or oösphere at the bottom. From a union of the antherozoids with the ova, or oöpheres, brought about through the agency of wind, moisture, rain, and other natural factors, new horsetail plants are produced.

Stems of two kinds: (a) A compound vegetative stem, normally well supplied with branches and branchlets, all chlorophyl-developing; and (b) a stout, simple, fertile stem that bears on its summit the sporangiophore, which consists of a closely-packed conical or spike-like cluster of stalked or pediceled peltate hexagonal or shield-shaped sporophylls, called *clypeolas*. Spore-bearing pockets (sporangia), 6 to 9, under the edge of each clypeola, one-celled, dehiscing by a longitudinal slit beneath. Leaves rudimentary, verticillate, at the summit of each joint, as many as the flutings, which alternate with the flutings in the joints above and below, and consisting of mere toothed sheaths having their edges joined together, thus making a leaf band at each node. This suggests the name *Equisetum*—*Equi*, equal, and *setum*, a bristle. The teeth are equal. Epidermis rough with silica. Stems and branches all chlorophyl-developing, making the possession of large leaves unnecessary.

Family 24. EUISETACEÆ: Horsetail Family.

159. *Equisetum arvense* L. Field horsetail. Sandy soil, eastern Kansas, west to Barton and Republic counties, and even farther; common. (A S U)
160. *Equisetum pratense* Ehrh. Meadow horsetail. Sandy meadows, E. K.; frequent.
161. *Equisetum fluviatile* L. River horsetail. Banks of streams, E. K., west to Ford county; frequent. (A S U)
162. *Equisetum robustum* A. Braun. Big scouring-rush. Barton county; not common. (S U)

ORDER IX. EQUISETALES: THE HORSETAILS.

Family 24. EQUISETACEÆ: Horsetail Family.

163. *Equisetum hyemale* L. Common scouring-rush. Banks and wet places along streams, E. K.; frequent. (A S U)
164. *Equisetum lævigatum* A. Br. Smooth scouring-rush. Along rivers and streams, generally throughout the state; common. (A S U)

Subphylum C. LEPIDOCAULONES: Club-mosses.

SCALY-STEMMED PTERIDOPHYTES.

Archegoniate plants, in which the stems, which are solid, are closely invested with minute imbricated scale-like leaves, arranged singly. Fibro-vascular bundles remain separate and do not form a closed cylinder. Method of fruiting somewhat similar to that of the *Arthrocaulones*, by means of sporangia and sporophylls in terminal cones; but the sporangia are single behind each sporophyll, and the cones are slender and lengthened into spikes.

Class V. LYCOPODINEÆ: Lycopods.

Gametophytes small, globular or tuber-like, with rhizoids which barely reach the ground.

Sporophytes with solid branching stems, more or less prostrate, crowded with small scale-like cauline leaves (whence the name *lepidocaulones*) arranged in four or more ranks. Sporophores (fertile branches) erect, greatly elongated, often 3 dm. in height; sporophylls and sporanges in four or more ranks, in a lengthened spike or cylinder at the summit. Sporangia one-to-three-celled, solitary in the axils of the sporophylls or on their upper surfaces. Spores yellowish, minute and all alike (homosporous) in the lycopods proper, or dimorphous (heterosporous) in the selaginellas. These are in separate sporanges, usually in cycles; sometimes with the androsporangia in the upper part of the spike and the gynosporangia in the lower part, and again in alternating cycles or otherwise. When homosporous the spores give rise to monœcious prothallia; when heterosporous the resulting prothallia are dioecious.

ORDER X. SELAGINELLALES: THE GROUND-FIRS.

(*Heterosporous Eusporangiate Lepidocaulones.*)

Evergreen archegoniates, producing two kinds of spores: (a) *androspores*, which are minute and roundish-prismoid, and carry minute biciliate sperms, like those of the mosses; and (b) *gynospores*, which are comparatively large and globose-angular, like a low triangular pyramid with a hemispherical base, similar to those of *Isoetes*, already described. From the gynospores, after fertilization by antherozoids from the androspores, are developed globular archegonial gametophytes resembling seeds. These plants are on the border line between archegoniate and carpellate; yet they are archegoniates all right, though only a few steps removed from the strobilophytes (cone-bearing plants).

Family 25. SELAGINELLACEÆ: Little Club-moss Family.

165. *Selaginella rupestris* Spring. Rock selaginella. Has been found nearly all around Kansas; not yet identified here.